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STUDY OF EFFECTS OF GROOVING ON PAVEMENT DETERIORATION SURVEY OF GROOVING OPERATIONS

I. Narrow

TECHNICAL REPORT NO. AFWL-TR-69-138

March 1970

AIR FORCE WEAPONS LABORATORY
Air Force Systems Command
Kirtland Air Force Base
New Mexico

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AFWL-TR-69-138

AIR FORCE WEAPONS LABORATORY
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STUDY OF EFFECTS OF GROOVING ON PAVEMENT

DETERIORATION SURVEY OF GROOVING OPERATIONS

I. Narrow

TECHNICAL REPORT NO. AFWL-TR-69-138

FOREWORD

This report was prepared by the Department of the Army, Ohio River Division Laboratories, Corps of Engineers, Cincinnati, Ohio, and the Construction Engineering Research Laboratory, Corps of Engineers, Champaign, Illinois, under Contract MIPR 69-21. The research was performed under Program Element 64708F, Project 921A, Task 5.3, and was funded by Hq USAF OCE.

Inclusive dates of research were January 1969 through December 1969. The report was submitted 16 February 1970 by the Air Force Weapons Laboratory Project Officer, Mr. Loren M. Womack (WLCT).

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This technical report has been reviewed and is approved.

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ABSTRACT

(Distribution Limitation Statement No. 2)

A survey of pavement grooving operations made at military and commercial airfields and by State Highway Departments is intended to serve as a basis for future evaluation of the effects of grooving on deterioration of rigid and flexible pavements. The survey covers runway grooving operations at seven airfields, grooving test installations at six airfields, and highway grooving by twelve State Highway Departments. Most of the pavement grooving has been accomplished within the past 2 years, and present pavement performance data are limited to this short period. The main difference between airfield and highway grooving has been in the direction of the grooving, airfield grooving being predominantly transverse and highway grooving parallel to the direction of traffic. However, there has been appreciable difference in performance of grooved airfield and highway pavements. Present condition of both rigid and flexible airfield pavements that have been grooved has been satisfactory with little evidence of deterioration. Grooved portland cement concrete highway pavements also have given satisfactory performance, with minor deterioration in cold weather areas attributed to use of tire chains and studded tires. Grooved asphalt concrete highway pavements have deteriorated rapidly in wheel paths where the grooves are obliterated leaving a shallow dishing effect. Because of differences in traffic volume and traffic patterns, separate pavement performance evaluations are necessary for airfield and highway pavements.

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TABLES

TABLES (cont'd)

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SECTION I

INTRODUCTION

1. Background

Vehicle skidding has been the subject of considerable study for many years, particularly factors contributing to skidding, skid-resistance measurements and methods of alleviating skidding. Pavement grooving as a means of improving skid resistance of airfield pavements was initiated in Great Britain about 10 years ago. In the past several years, this method of improving skid resistance has received considerable attention in this country. Much research and experimental work is being conducted for both airfield and highway uses. Extensive research on pavement grooving is being conducted at the NASA Langley Research Center, and various aviation agencies are conducting runway grooving experiments as well as large scale grooving operations at a number of commercial and military airfields. A large number of State Highway departments also are experimenting with pavement grooving as a means of reducing skidding in high-accident locations.

Results of the grooving experiments in improving vehicle control by eleminating hydroplaning and side-skidding have been very impressive. However, since pavement grooving is a relatively new operation, little information is available at present about the effects of the grooving on pavement deterioration.

2. Purpose and Scope

The purpose of this study is to determine the effects of grooving of rigid and flexible pavements in contributing to premature deterioration of the pavements. The initial phase of this program consists of a survey to determine where pavement grooving operations have been accomplished and what studies are being conducted with regard to pavement performance. This survey is intended to provide information which will serve as a basis for future evaluation of pavement performance.

Various agencies which have been involved in pavement grooving operations were contacted, including National Aviation and Space Administration, Federal Aviation Administration, Commercial and Military Airports and State Highway Departments. Information has been obtained regarding pavement locations and types, grooving dates, groove details, pavement evaluation programs and present condition of pavements. Results of this survey are presented and discussed in this report.

SECTION II

PAVEMENT GROOVING OPERATIONS

1. Airfield Pavements

This survey covers full scale runway grooving programs at five commercial and two military airfields as well as small grooving test installations at six airfields, as follows:

a. Commercial Airfield Runway Grooving

(1) Washington National Airport

(2) Kansas City Municipal Airport

(3) New York Kennedy International Airport

(4) Charleston, W. Va. (Kanawha County) Airport

(5) Chicago Midway Airport

b. Military Runway Grooving

(1) Beale AFB, California

(2) Seymour Johnson AFB, North Carolina

c. Grooving Test Installations

(1) Miami International Airport

(2) Salt Lake City Municipal Airport

(3) Las Vegas McCarran Airport

(4) Cleveland Hopkins Municipal Airport

(5) New York Kennedy International Airport

(6) NASA Wallops Station Runway

Grooving operations at these airfields are described in Tables I through IX (Appendix I).

2. <u>Highway Pavements</u>

Available records indicate that grooving of highway pavements to improve skid resistance was initiated on an experimental basis in 1962 by California and Texas Highway Departments. Additional grooving has been conducted in California since 1965 and this State has done much experimental work with groove patterns and skid resistance test. Within the past 2 years, many other states have experimented with grooving of highway pavements in high-accident locations, and this use is increasing rapidly. A review of highway grooving operations is presented in Tables X through XXI (Appendix I).

SECTION III

DISCUSSION

1. Airfield Pavement Grooving

The initial NASA studies of various groove configurations showed that the greatest increase in traction was obtained with a 1/4-in. wide by 1/4-in. deep groove on a 1-in. spacing. Further experimentation with various groove dimensions and details is now being conducted. These studies include 18 different groove patterns which are being used in an environmental test program at five different airfields with a wide range in weather conditions. Typical groove patterns for the environmental test program are shown in Figure 1. Groove details used for the runway grooving programs varied appreciably as follows: width, 1/8 to 3/8 in.; depth, 1/8 to 1/4 in.; spacing 1 to 1-3/8 in. All grooving of airfield pavements has been done in a transverse direction. In general, the grooving has been continuous over the entire area of pavement grooved. However, at one Air Force Base, the pavements were grooved transversely in 2-ft-wide strips alternately with 2-ft strips of ungrooved pavement.

The comments received regarding the condition of the grooved runway pavements after about 12 to 18 months in service indicated that both the portland cement concrete (PCC) and asphaltic concrete (AC) pavements were in good condition. There was a slight accumulation of rubber in touchdown areas but this was not considered significant. There has been a slight increase in popouts and in spalling in cracked areas of PCC pavements at Kansas City Airport, but no

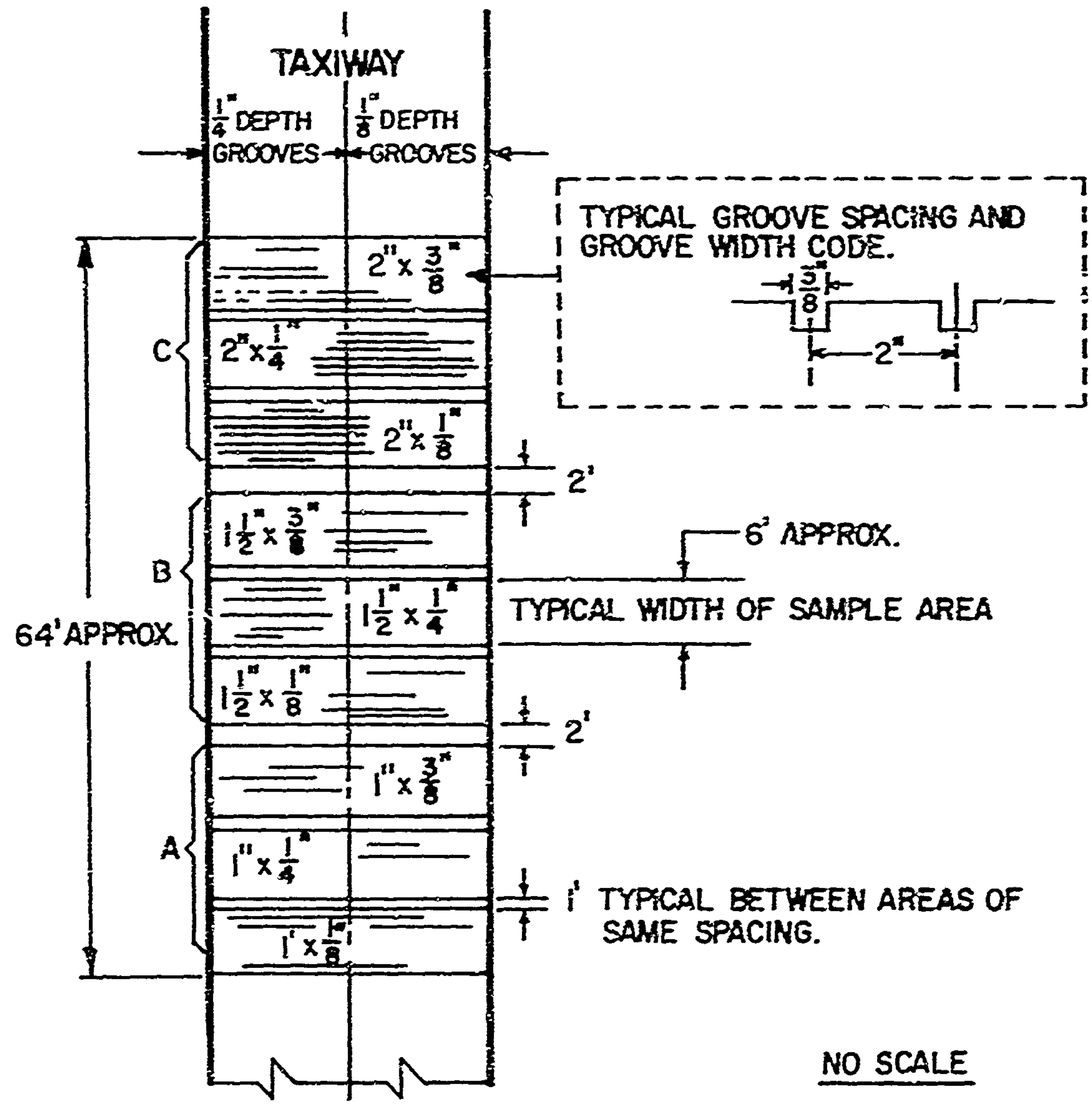

FIGURE 1– FAA ENVIRONMENTAL TEST PROGRAM–TYPICAL GROOVED TAXIWAY PATTERNS

deterioration of asphalt pavements. It should be realized that the reported service records are based on very short use periods. Performance could change rapidly under severe exposure conditions. All of the reports indicate that resistance to skidding and hydroplaining on wet pavements is greatly improved. Pilot reaction has been highly favorable with comments that braking and direction controls on grooved wet pavements are equal to those on dry pavements.

2. Highway Pavement Grooving

With the exception of a small amount of pavement grooving done in California and Texas in 1962, practically all of the grooving by the various Highway Departments has been done since 1966. The data represent highway grooving accomplished in 12 states. Most of this grooving has been of an experimental nature in high-accident areas, mainly on highway curves. Practically all of the grooving has been in a longitudinal direction parallel to the highway centerline. Transverse grooving has been used in a few small test sections primarily for comparison with longitudinal grooving. A variety of groove patterns has been used ranging from 1/8-in. to 1/4-in. in width and depth and from 3/8-in. to 1-in. in spacing. The most common pattern has a 1/8-in. groove width and depth at a spacing of 3/4 or 1-in. Some of the groove patterns used are shown in Figure 2. Except for individual State programs there apparently has been no coordinated research on groove patterns.

Of the four states which commented on grooving of AC pavements, all indicated early deterioration of the grooves and unsatisfactory performance.

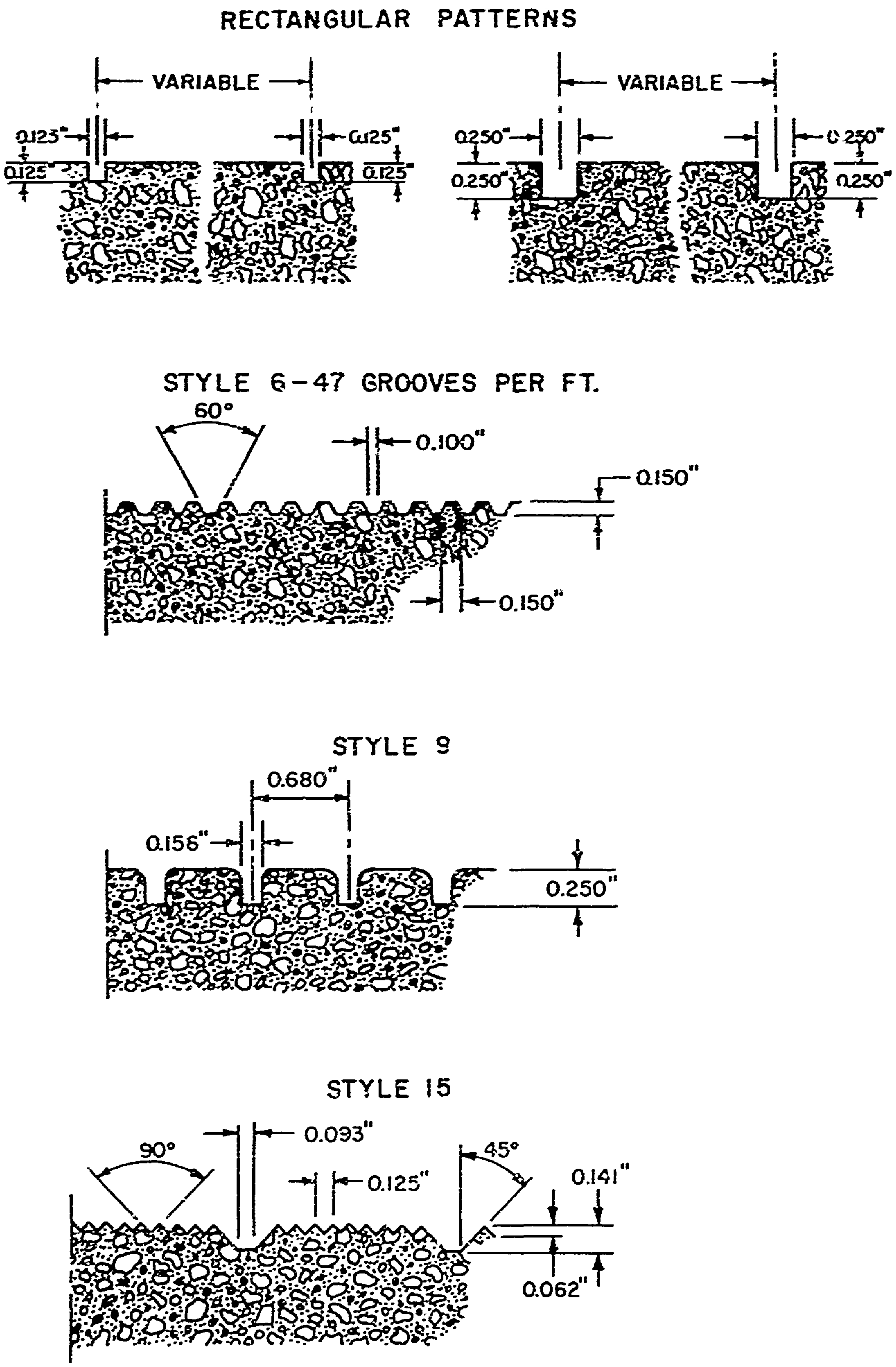

FIGURE 2-GROOVING PATTERNS USED ON VARIOUS PROJECTS

The grooves tend to knead together under traffic resulting in a shallow "dishing" in the wheel path with grooves rapidly disappearing, especially during warm weather. The performance of the grooving in PC concrete generally has been considered satisfactory during the relatively short period in use. However, there are some indications that groove performance may vary appreciably, depending on weather conditions in the area. Many states, in areas where cold weather and snow are common, reported that the grooves in PCC pavements show some wear and deterioration at the edges. This generally was attributed to use of studded tires and tire chains. In a number of instances, it was reported that the longitudinal grooving gave no improvement in friction tests. The main benefit was considered to be the change in skidding pattern from sideways to straight line, which prevented skidding accidents by improving control of the vehicle.

3. General Comments

Interest in pavement grooving as a means of reducing skidding accidents during wet weather has grown rapidly during the past several years and numerous grooving programs have been initiated by various airfield and highway agencies. At the present time, there are no standard grooving details and many of the grooving programs are of an experimental nature to investigate groove details and effectiveness of the grooving in reducing skidding and hydroplaning. The effect of grooving on pavement deterioration also is being evaluated by routine inspections of the pavements during use.

Grooving of AC highway pavements has not been very successful. The concentration of traffic in narrow wheel paths tends to compact the surface to produce a shallow depression without grooves. For airfields, the smaller traffic volume and greater dispersal of the traffic has resulted in better performance of grooves in AC pavements during the short period in use. Further evaluation of grooved AC pavements at airfields will be necessary to determine long time performance.

Grooved PCC pavements have given satisfactory performance both for airfield and for highway uses. Again, traffic conditions are more severe for highway pavements because of the greater volume and concentration of traffic, and because of wear from tire chains and studded tires in certain areas. These abrasive conditions are not present with aircraft traffic where weathering of the pavement surface is the most important factor.

SECTION IV

CONCLUSIONS

The survey of pavement grooving operations provides information for use in future evaluation of pavement performance.

For airfield pavements, preliminary indications are that grooving has had only a minor effect on deterioration of either rigid or flexible pavements after about 18 months of service.

During a period of about 2 years or less, only minor deterioration of grooved PCC highway pavements has been evident, but grooves in AC highway pavements have deteriorated rapidly.

Highway pavements have more rapid deterioration of the grooves, because they are subjected to greater volume and more severe traffic conditions than airfield pavements.

SECTION V

RECOMMENDATIONS

It is recommended that additional service records be obtained and field surveys be made for future evaluation of deterioration of grooved pavements.

Because of differences in grooving details, skid resistance requirements, and traffic effects, separate evaluations of pavement deterioration should be made to determine performance of airfield and highway pavements.

SECTION VI

REFERENCE LIST OF CONTACTS

Airfield Grooving

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Langley Research Center
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Federal Aviation Administration
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Washington, D. C. 20590

Port of New York Authority
J. F. Kennedy International Airport
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Kansas City Aviation Department
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Department of Transportation
Federal Aviation Administration
Bureau of National Capital Airports
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Kanawha County Airport
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Charleston, W. Virginia

Chicago Midway Airport
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Beale Air Force Base, California 95903

Department of the Air Force
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Highway Grooving

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Jackson, Mississippi

New Jersey Department of Transportation
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Nevada Department of Highways
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Utah State Department of Highways
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Salt Lake City 14, Utah

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APPENDIX I

TABLES

Table I
Commercial Airfield Grooving
(Washington National Airport)

	N-S Runway 18-36
Pavement Type	AC
Grooving Date	Mar-April 1968
Grooved Area	
Length, ft.	6, 870
Width, ft.	150
Area, sq. yd.	114, 500
Groove Details	
Width, in.	1/8
Depth, in.	1/8
Spacing, in.	1
Direction	Trans

Note: Pavement inspected daily in routine manner by operation and maintenance personnel. Other inspections for evaluation about every 6 months. After 18 months pavement is in generally satisfactory condition. Slight accumulation of rubber in grooves in touchdown area.

Table II
Commercial Airfield Grooving
(Kansas City Municipal Airport)

	Runway 18-36	
Pavement Type	PCC	AC
Grooving Date	Apr-May 1967	Apr-May 1967
Grooved Area		
Length, ft.	2,500	2,000
Width, ft.	130	130
Area, Sq. yd.	36,000	28,000
Groove Details		
Width, in.	1/8	1/8
Depth, in.	1/4	1/4
Spacing, in.	1	1
Direction	Trans	Trans

Note: Slight increase in concrete deterioration but not serious. Increase in popouts and in spalling in cracked areas. No increase in deterioration of asphalt pavements. Continuing program to check surface condition of grooved pavements.

Table III
Commercial Airfield Grooving
(New York Kennedy International Airport)

	Runway 4R-22L
Pavement	PCC
Grooving Date	May-Aug 1969
Grooved Area:	
Length, ft.	8,400
Width, ft.	140
Area, sq. yd.	122,000
Groove Details:	
Width, in.	3/8
Depth, in.	1/8*
Spacing, in.	1 3/8
Direction	Trans

*Shaped rounded bottom

Note: Frequent inspections made. No spalling or breakdown of grooves and no significant accumulation of rubber after 16-month period.

Table IV
Commercial Airfield Grooving
(Charleston, W. Va. Airport)

	Main Runway	
Pavement Type	PCC	AC
Grooving Date	Nov. 1968	Nov. 1968
Grooved Area:		
Length, ft.	400	5,200
Width, ft.	140	140
Area, sq. yd.	6,200	80,900
Grooved Details:		
Width, in.	1/4	1/4
Depth, in.	1/4	1/4
Spacing, in.	1 1/4	1 1/4
Direction	Trans	Trans

Note: Pavement inspected daily. Present condition is excellent.

Table V
Commercial Airfield Grooving
(Chicago Midway Airport)

	Runway* 31L/13R		Runway* 22L/4R	
Pavement Type	PCC	AC	PCC	ACC
Grooving Date	July - Sept. 1968		July - Sept 1968	
Grooved Area:				
Length, ft.	6, 520	6, 520	6, 100	6, 100
Width, ft.	100	4	100	4
Area, sq. yd.	72, 400	2, 900	67, 700	2, 700
Groove Details:				
Width, in.	1/4	1/4	1/4	1/4
Depth, in.	1/4	1/4	1/4	1/4
Spacing, in.	1 1/4	1 1/4	1 1/4	1 1/4
Direction	Trans	Trans	Trans	Trans

*Each runway is 100 ft. wide PCC pavement with 37-1/2 ft. AC shoulder each side. Grooving extends across 100 ft. PCC and 2 ft. into AC shoulder on each side.

Comment: About 2 months after grooving some spalling was noticed on one side of centerline and in various areas which appeared to be due to stresses in pavement above keyway. No deficiences have been detected which could be caused by the grooving.

Table VI
Military Airfield Grooving
(Beale Air Force Base, California)

	Main Runway
Pavement Type	PCC
Grooving Date	Oct. '67 to Feb. '68
Grooved Area:	
Length, ft.	10, 800
Width, ft.	140
Area, sq. yd.	168, 000
Groove Details:	
Width, in.	1/4
Depth, in.	1/4
Spacing, in.	1
Direction	Trans

Note: Pavement condition is excellent. No spalling of grooves noted, and after 6 months no excess tire wear is evident. Pilot reaction is highly favorable; pilots state that braking and direction controls on wet grooved surface are equal to dry surface.

Table VII
Military Airfield Grooving
(Seymour-Johnson AFB, North Carolina)

	E-W Runway	
Pavement Type	PCC	AC
Grooving Date	Sept-Nov 1968	Sept-Nov 1968
Grooved Area:		
Length, ft.	7, 658 2, 100	7, 658
Width, ft.	75 140	65
Area, sq. yd.	96, 000	55, 000
Groove Details:*		
Width, in.	1/4	1/4
Depth, in.	1/4	1/4
Spacing, in.	2	2
Direction	Trans	Trans

Note: Pavement grooved transversely alternately grooving 2-ft. width and skipping 2-ft. width.

Comment: No comments on pavement performance or skid performance as grooving was just completed.

Table VIII
Airfield Pavement Grooving Tests
(NASA Wallops Station)

	Landing Research Runway 4-22	
Pavement Type	PCC	AC
Grooving Date	1966	1966
Grooved Area		
Length, ft.	700	700
Width, ft.	50	50
Area, sq. yd.	3, 900	3, 900
Groove Details		
Width, in.	1/4	1/4
Depth, in.	1/4	1/4
Spacing, in.	1	1
Direction	Trans.	Trans.

Note: Runway test sections for tests under a variety of controlled conditions.

Table IX
FAA Environmental Test Program

Airport	Test Environment	Pavement		Date Grooved
		No.	Type	
Miami International	Hot/Wet	11	AC	July 1967
Las Vegas McCarran	Hot/Dry	B	AC	April 1967
Salt Lake City Municipal	Heavy Snow	1	AC PCC	April 1967
Cleveland Hopkins	Rain/Sleet/Snow	O L	AC PCC	April 1967
New York J. F. Kennedy	Rain/Sleet/Snow	M Y	AC PCC	Sept. 1967

Note: Test areas contain 18 different groove patterns. See Figure 1 for details.

Table X
Highway Pavement Grooving
(California Division of Highways)

	Golden State Freeway 06-Kern-5 PM6.94-7.47	Golden State Freeway 07-LA-5 PM78.35-78.85	Golden State Freeway 07-LA-5 PM29.5-30.0	Santa Ana Freeway 07-ORA-5 PM23.3-23.6	San Bernardino Freeway 07-LA-10 PM22.6-22.8	San Diego Freeway 07-LA-405 PM2.1-2.6, 3.8-4.1
Pavement Type	PCC	PCC	PCC	PCC	PCC	PCC
Grooving Date	1962	Jan 1963	Jan-Mar '66	Jan-Mar '66	Jan-Mar '66	Jan-Mar '66
Area	0.5 miles	0.5 miles	4 Lanes, 0.5 mi	2 Lanes, 0.3 mi.	4 Lanes, 0.2 mi.	2 Lanes, 0.5 mi. 1 Lane, 0.3 mi.
Groove Details:						
Width, in.	1/8	3/16	1/8	1/8	1/8	1/8
Depth, in.	1/8	1/8	1/8	1/8	1/8	1/8
Spacing, in.	3/8	3/8	3/4	1/2	3/4	1
Direction	Long	Long	Long	Long	Long	Long

Note: Consider that longitudinal grooving provides better stability around curves than transverse grooving. Prefer seal coat to grooving of AC pavements as kneading by traffic tends to close grooves. Recommend use of 1/8 x 1/8-in. grooves with 3/4-in. spacing.

Table X (Cont'd)

	Hollywood Freeway 07-LA-101(1) PM 8.8-9.3	I-80 near Nevada State Line 03-NEV-80(2) PM 19.8-20.2	03-Pla, Nev-80 5 Locations PM 5.00-45.60	Placerita Canyon Bridge 07-LA-14-27.89	07-VEN-101	Bridge Decks 10-Sta-4-A 04-Ala-7-Alb
Pavement Type	AC	PCC	PCC	PCC	PCC	
Grooving Date	Jan-Mar '66					
Area	10 Lanes, 0.5 miles	0.4 miles	0.9 miles		100 ft test sections, each style	
Groove Details:						
Width, in.	1/4	1/8	1/8	Christensen	Christensen	1/8
Depth, in.	1/4	1/8	1/8	Styles 9&15	Styles 9, 6 & 15	1/8
Spacing, in.	1	1	1	See Fig 2	See Fig 2	3/8
Direction	Long	Long	Long	Long	Long	Long

(1) Groove width of 1/4-in creates problem in control of motorcycles and light cars.

(2) Considerable spalling between grooves believed due to use of chains in winter.

Table XI
Highway Pavement Grooving
(Minnesota Department of Highways)

	I-94 St. Paul	I-35W Minneapolis	I-494 S. St. Paul	I-90 Austin	TH-10 Staples	TH-60 Mankato	TH-71 Jackson	TH-169 Mankato	TH-169 St. Peter
Pavement Type	PCC	PCC	PCC	PCC	PCC	PCC	PCC	PCC	PCC
Grooving Date	Summer 1967	Summer 1967	Summer 1967	Summer 1968	Summer 1968	Summer 1968	Summer 1968	Summer 1968	Summer 1968
Area, sq. ft.	28, 800	180, 000	40, 500	58, 390	19, 800	40, 800	57, 600	12, 000	24, 000
Groove Details:									
Width. in.	1/8	1/8	1/8	Christen-sen Style 15	1/8	1/8	1/8	1/8	1/8
Depth, in.	1/8	1/8	1/8	See Fig 2	1/8	1/8	1/8	1/8	1/8
Spacing, in.	3/4	3/4	3/4		3/4	3/4	3/4	3/4	3/4
Direction	Long	Long	Long	Long	Long	Long	Long	Long	Long

Note: Use of bumpcutting machine resulted in shallow grooves in low areas because of surface irregularities. Noticeable wear in wheel paths has occurred after one winter (1967 grooving) which is attributed to use of studded tires in the high density traffic areas. Skid performance has been very effective.

Table XII
Highway Pavement Grooving
(Ohio Department of Highways)

	I-71 Morrow County	I-71, Ramps Allen County	I-270, Ramps Franklin County	I-75 Allen County
Pavement Type	PCC	PCC	PCC	PCC
Grooving Date	Dec. 1966	Nov. 1966	Nov. 1966	May 1968
Area, sq. ft.	210,000	7,300	18,000	192,000
Groove Details:				
Width, in.	1/8 to 3/16	1/8 to 3/16	1/8 to 3/16	1/8 to 3/16
Depth, in.	1/8 to 3/16	1/8 to 3/16	1/8 to 3/16	1/8 to 3/16
Spacing, in.	1/2 to 3/4	1/2 to 3/4	1/2 to 3/4	1/2 to 3/4
Direction	Long	Long	Long	Long

Note: Condition of all grooved pavements is good. Have had a few reports of slight weaving with some types of vehicles.

Table XIII
Highway Pavement Grooving
(Texas Highway Department)

	I-35 in San Antonio	I-35 in San Antonio
Pavement Type	PCC	PCC
Grooving Date	July to Sept. 1962	Summer 1966
Area, sq. ft.	344,000 (1.2 miles)	Adjacent 100 ft. section
Groove Details:		
Width, in.	3/16	--
Depth, in.	1/8	--
Spacing, in.	1/2	--
Direction	Long	Trans

Note: The longitudinal grooving produced little change in skid resistance, and main benefit was a change in skidding pattern from sideways to straight line. Grooved pavement was overlaid with asphalt, partly in 1963 and partly in 1964. Useful life of grooving was only about 6 months. The transverse grooving improved skid resistance originally but all benefits were lost after 10 months. Short improvement period is attributed to soft aggregate used in the concrete.

Table XIV
Highway Pavement Grooving
(Washington Department of Highways)

	Snoqualmie Pass Summit	I-5 Toutle River Bridge Approach
Pavement Type	PCC	AC
Grooving Date	Nov. 1967	Nov. 1967
Area, sq. ft.	29,000	91,200
Groove Details:		
Width, in.	1/8	1/8
Depth, in.	3/16	3/16
Spacing, in.	1	1
Direction	Long	Long

Note: Present condition of both pavement areas is good. There is some tendency of asphalt to flow under traffic. Friction tests show no improvement, but skidding is prevented by improving lateral stability and hydroplaning effects.

Table XV
Highway Pavement Grooving
(North Carolina Highway Commission)

	Intersection I-85 and US 29
Pavement Type	PCC
Grooving Date	June 1967
Area sq. ft.	47, 000
Groove Details:	
Width, in.	1/8
Depth, in.	1/8
Spacing, in.	9/16
Direction	Long - 33, 000 sq. ft. Trans - 14, 000 sq. ft.

Note: Present condition of grooves is excellent. No skid tests made but accident record improved.

Table XVI
Highway Pavement Grooving
(Utah Department of Highways)

	Parleys-Canyon Project Salt Lake City	I-15 Project
Pavement Type	PCC	PCC
Grooving Date	Dec. 1966	Aug. 1968
Groove Details*		
Style #7, Trans	1,200 sq. ft.	--
Style #9, Trans	1,200 sq. ft.	--
Style #9, Long.	1,200 sq. ft.	--
Style #15, Trans	1,200 sq. ft.	4,800 sq. ft.
Style #15, Long.	--	480 sq. ft.
Style #6, Trans	--	2,400 sq. ft.

*See Figure 2 for groove details

Note: Parley Canyon Project is in generally good condition with some degradation on the peaks of the saw cuts. I-15 Project has had no traffic.

Table XVII
Highway Pavement Grooving
(Colorado Department of Highways)

	I-25 in Denver	
Pavement Type	PCC	AC
Grooving Date	Mar. 1968	Mar. 1968
Area, sq. ft.	4,200	4,200
Groove Details:		
Width, in.	1/8	1/8
Depth, in.	1/8	1/8
Spacing, in.	5/8	5/8
Direction	Long.	Long.

Note: (1) Concrete. After 5 months, grooves in PCC pavement are good but slightly rounded at edges, possibly because of metal studded tires.

(2) Asphalt. Grooves in AC pavement started to knead in June (about three months) when weather turned warm. By July, grooves in wheel tracks were barely visible with "dishing" to about 1/8-in depth. Between wheel tracks there is only slight evidence of the grooving.

Table XVIII
Highway Pavement Grooving
(Pennsylvania Department of Highways)

	US 322 near Hummelstown	
Pavement Type	PCC	AC
Grooving Date	April 1967	April 1967
Area, sq. ft.*	4,400	1,700
Groove Details		
Width, in.	3/16	3/16
Depth, in.	1/16	1/8
Spacing, in.	1	1
Direction	Long	Long

*Pavement length of 1,025 ft. (PCC-740-ft., AC-285 ft.) grooved 3-ft. width in each wheel path used in grooving equipment.

Note: No comments on pavement condition, but reported "-alarming tendency for vehicles to weave as a result of driving over the longitudinal grooves."

Table XIX
Highway Pavement Grooving
(Mississippi Highway Department)

	Lynch St. in Jackson
Pavement Type	PCC
Grooving Date	Oct. 1966
Area, sq. ft.	1,615
Groove Details	
Width, in.	--
Depth, in.	1/8
Spacing, in.	3/8
Direction	Trans

Note: Test section for grooving demonstration rated excellent in skid tests after 1 year.

Table XX
Highway Pavement Grooving
(New Jersey Department of Transportation)

	Rte 439 Hillside
Pavement Type	PCC
Grooving Date	Recent
Area sq. ft.	--
Groove Details	
Width, in.	1/8
Depth, in.	3/16
Spacing, in.	3/4
Direction	--

Note: No deterioration in short time elapsed. Grooving did not appreciably improve skid resistance.

Table XXI
Highway Pavement Grooving
(Nevada Highway Department)

	Experimental Sections
Pavement Type	AC
Grooving Date	--
Area, sq. ft.	--
Groove Details:	
Width, in.	3/8 to 1/2
Depth, in.	1/8 to 1/4
Spacing, in.	2
Direction	Long

Note: The most extensively used method is a heater-planer device which softens the asphalt surface followed by 1 2-in steel rods mounted on an 8-ft. bar at a 2-in. spacing set to produce grooves 1/8 to 1/4-in. deep. Other methods used included sawtooth blades or cutting discs mounted on a motor patrol which produced grooves 1/2 to 1 1/2-in. wide by 3/16-in. deep with spacings of 3 to 4 1/2-in.

All methods gave initial improvement in skid resistance but rapid wear resulted in complete loss of grooved effect in wheel path in as little as 5 months. Grooving tends to shorten pavement life by exposing more surface resulting in accelerated deterioration of the asphalt and erosion of mineral components.

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14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Pavement grooving						
Pavement deterioration						
Skid resistance						
Hydroplaning						